Advances in Treatment of Coronary Artery Disease

Dr Fam JM
Consultant
Interventional Cardiology
National Heart Centre Singapore
Scope

• Introduction

• Current and Future Direction in Stents
  • Novel Developments in DES
  • BRS

• Issues in Pharmacological Therapy- Use of AntiPlatelets and Duration of Dual AntiPlatelet Therapy (DAPT)

• Functional Assessment and Intravascular Imaging

• Conclusion
Introduction
Survival Benefit of Revascularisation

Figure 4. Log hazard ratio for revascularization (Revasc) vs medical therapy (Medical Rx) as a function of % myocardium ischemic based on final Cox proportional hazards model.

*p<0.001

Introduction

• Percutaneous coronary intervention,
  • One of the main modes of revascularisation
  • pioneered in 1977,
  • one of the most frequently performed therapeutic procedure in medicine.

• The earlier use of balloon angioplasty, was limited by abrupt vessel closure due to dissections and restenosis.

• Coronary Stents
  • were developed to maintain lumen integrity.
  • improved procedural safety and efficacy and eliminated the need for surgical standby.
Coronary Artery Stents- Mainstay of Percutaneous Coronary Intervention

- A small tubular wire mesh device preloaded in a collapsed form onto a catheter balloon
- Threaded to the diseased section of the coronary artery and expanded within the vessel
Bare Metal Stents

• However, stent mediated arterial injury -> neointimal hyperplasia, -> restenosis -> need for repeat revascularization in up to 1/3 of patients\(^1\) at 6-12 mths
• In stent restenosis (defined as >50% in the stented area)
• Up to 10% of restenosis presents with MI
• Risk of restenosis increases in certain disease and anatomic subsets; diabetes, renal impairment, long lesions, bifurcations

Drug Eluting Stents

- Controlled local release of antiproliferative agents -> suppress neointimal hyperplasia
- Reduced the risk of repeat revascularization, as compared with bare metal stents
- DES slower and less complete endothelization compared to BMS
- Required longer duration of dual antiplatelets

Situations when BMS preferred
- Elderly (higher bleeding risk)
- Comorbidities; underlying anaemia, require anticoagulation
- Require surgery soon
- Patient compliance is suspect
Platforms for Drug Eluting Stents

- Drug-eluting stents have three components: a metallic stent platform, a polymer coating, and a pharmacological agent.
**1st and 2nd generation Drug Eluting Stents**

- Early-generation stents released sirolimus or paclitaxel and had stainless-steel platforms.
- New-generation stents release everolimus or zotarolimus and feature cobalt-chrome or platinum-chrome platforms with thinner strut thickness and more biocompatible, durable polymer coatings.
- These new-generation stents have almost completely replaced paclitaxel-eluting stents in clinical practice.
- Sirolimus-eluting stents are no longer manufactured.
## History of DES in Asia

<table>
<thead>
<tr>
<th></th>
<th>Cypher</th>
<th>Taxus</th>
<th>Endeavour</th>
<th>Xience</th>
<th>Promus</th>
<th>Nobori</th>
<th>Resolute Integrity</th>
<th>Ultimaster</th>
<th>Synergy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>Johnson &amp; Johnson</td>
<td>Boston Scientific</td>
<td>Medtronic</td>
<td>Abbott Vascular</td>
<td>Boston Scientific</td>
<td>Terumo</td>
<td>Medtronic</td>
<td>Terumo</td>
<td>Boston Scientific</td>
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</table>

### Strut Thickness (Inch)

<table>
<thead>
<tr>
<th></th>
<th>1st</th>
<th>2nd</th>
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<tbody>
<tr>
<td>Year</td>
<td>2004</td>
<td>2007</td>
</tr>
<tr>
<td>Strut Thickness (Inch)</td>
<td>0.0055</td>
<td>0.0036</td>
</tr>
<tr>
<td></td>
<td>0.0038</td>
<td>0.0032</td>
</tr>
</tbody>
</table>

### Polymer Thickness

<table>
<thead>
<tr>
<th></th>
<th>PEVA/PBM A 7.2µm</th>
<th>SIBS (Translute) 5.6µm</th>
<th>PC 4.0µm</th>
<th>Fluropolymer 5.3µm</th>
<th>Fluropolymer 5.3µm</th>
<th>PLA/Polyethylene 20µm</th>
<th>Biolinx 5.6µm</th>
<th>PDLLA-PCL polymer 15µm</th>
<th>PLGA polymer 4µm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drug/release duration</td>
<td>Sirolimus 90 days (100%)</td>
<td>Paclitaxel 14 day (100%)</td>
<td>Zotarolimus 120 day (100%)</td>
<td>Everolimus 120 day (100%)</td>
<td>Everolimus 120 day (100%)</td>
<td>Biolimus A9 180 day</td>
<td>Zotarolimus 180 day (100%)</td>
<td>Sirolimus 3-4 M</td>
<td>Everolimus 4M</td>
</tr>
</tbody>
</table>
2nd Gen DES- Everolimus

- Xience V
  - Drug concentration of 100ug per cm² of stent surface area
  - Releases 80% of drug within 30 days
  - Multi-Link Vision BMS (closed cell slotted tube; cobalt chromium)
Novel Developments

PTCA → BMS → DES → Bioresorbable polymer/scaffolds

? 4th Revolution
Problems encountered with DES

• Contemporary DES
  • Highly deliverable
  • <5% (simple lesions) - 15% restenosis at 1 year
  • ≤ 0.5% stent thrombosis at 1 year

Issues
Chronic effects of limus-drugs
Strut fracture
Polymer-related inflammation

Neoatherosclerosis
Late Stent Malapposition
Late Stent Thrombosis
Novel Approaches to Improve late DES outcomes

- Metallic DES with bioresorbable polymers (Polymer degrades quickly)
- Metallic DES, polymer-free (No polymer at all)
- Bioresorbable vascular scaffolds (BRS) (Whole stent goes away)
DES with durable or biodegradable polymer coatings

SYNERGY- Abluminal Bioresorbable Polymer

- Platform: platinum chromium (74um)
- Polymer coating: Abluminal coating, 4um thick, biodegradable, undetectable in 4 mths. PLGA (poly-lactic co-glycolic acid).
- Drug: Everolimus (100ug/cm2); elutes in 3 months
Bioresorbable Vascular Scaffolds (BRS)

- **Igaki-Tamai** - first fully bioresorbable stent to be implanted in humans, with complete degradation taking 18 to 24 months. Helical zig zag design -> less vessel wall injury
- **Abbott Absorb** - PLLA (eluting everolimus)
- **Elixir DESolve** - PLLA (eluting novolimus)
- **Reva ReSolve** - Iodinated tyrosine-derivative (eluting sirolimus)
- **Biotronik Dreams** - Magnesium (eluting sirolimus)

- PLLA - poly-L-lactic acid (PLLA)
- Igaki-Tamai: PLLA degrades to lactic acid, which is metabolized via the Krebs cycle. Almost 100% resorbed at 24mths
- Absorb: most widely commercially available. PLLA and PDLLA degrade to lactic acid, which is metabolized via the Krebs cycle. Almost 100% resorbed at 24mths
- Reva: the REVA stent has a distinctive slide-and-lock design that provides both flexibility and strength
- Dreams: high target lesion revascularisation due to stent design
Absorb-BVS$^R$

- Balloon-expandable scaffold
  - a polymer backbone of poly-L-lactide (PLLA)
  - coated with a thin layer of a 1:1 mixture of an amorphous matrix of poly- D, L-lactide (PDLLA) polymer
    - 80% of everolimus (100 μg/cm$^2$) is eluted within the first 30 days.
    - Both PLLA and PDLLA are fully bioresorbable.

- Two radiopaque edge platinum markers
Process of resorption of the Absorb BVS

- Initial reduction in molecular weight
- Reduction in radial support at 6 mths
- Loss in mass at 12mths, near complete resorption at 24 mths
- Progressive change in in PLLA chains and fragmentation of crystalline lamellae
Potential benefits of BRS

• Less long term thrombotic risk after resorption

• Improved vessel recovery
  • Recovery of vessel vasomotion
  • Possible Improved angina effect

• Improved conformability

• Late luminal enlargement (IVUS findings in Absorb Cohort A)
# Meta-analysis: BRS vs DES

## Table 1 Meta-analyses comparing BVS to metallic DES

<table>
<thead>
<tr>
<th>Meta-analysis</th>
<th>Target lesion revascularization</th>
<th>Acute myocardial infarction</th>
<th>Thrombosis (definite and probable)</th>
<th>Cardiac death</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stone et al. [2016] (11)</td>
<td>1.14 (0.73–1.79)</td>
<td>1.45 (1.02–2.07)</td>
<td>2.09 (0.92–4.75)</td>
<td>1.26 (0.33–4.82)</td>
</tr>
<tr>
<td></td>
<td>P=0.56</td>
<td>P=0.04</td>
<td>P=0.08</td>
<td>P=0.74</td>
</tr>
<tr>
<td>Cassese et al. [2016] (12)</td>
<td>0.97 (0.66–1.43)</td>
<td>1.36 (0.98–1.89)</td>
<td>1.99 (1.0–3.98)</td>
<td>0.95 (0.42–2.00)</td>
</tr>
<tr>
<td></td>
<td>P=0.87</td>
<td>P=0.06</td>
<td>P=0.05</td>
<td>P=0.89</td>
</tr>
<tr>
<td>Lipinski et al. [2016] (13)</td>
<td>0.77 (0.48–1.25)</td>
<td>2.06 (1.31–3.22)</td>
<td>2.06 (1.07–3.98)</td>
<td>0.81 (0.42–1.58)</td>
</tr>
<tr>
<td></td>
<td>P=0.36</td>
<td>P=0.002</td>
<td>P=0.03</td>
<td>P=0.54</td>
</tr>
</tbody>
</table>

Results are provided as odds or risk ratios with 95% confidence interval. Values >1 reflect increased risk or odds with the use of BVS. BVS, bioresorbable vascular scaffold; DES, drug-eluting stent.

BRS and Thrombosis

• First generation Absorb BRS carries an increased risk of 1 year scaffold thrombosis compared with best in class DES (CoCr-EES)

• Timing of thrombosis appears to be evenly distributed from acute to very late events.
  • Similar to DES, predisposing factors appears to be suboptimal implantation (ie underexpansion, acute malapposition)
  • Late and very late BRS thrombosis may be triggered by DAPT discontinuation

• Prevention of thrombosis involves careful patient selection, best implantation practice and long term DAPT.
Issues in Pharmacological Therapy- AntiPlatelets

• New generation antiplatelets
  • Ticagrelor
  • Prasugrel
  • Cangrelor

• Duration of DAPT
# P2Y$_{12}$ Inhibitors

<table>
<thead>
<tr>
<th></th>
<th>Clopidogrel</th>
<th>Prasugrel</th>
<th>Ticagrelor</th>
<th>Cangrelor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chemical class</strong></td>
<td>Thienopyridine</td>
<td>Thienopyridine</td>
<td>Cyclopentyl-triazolopyrimidine</td>
<td>Stabilized ATP analogue</td>
</tr>
<tr>
<td><strong>Administration</strong></td>
<td>Oral</td>
<td>Oral</td>
<td>Oral</td>
<td>Intravenous</td>
</tr>
<tr>
<td><strong>Dose</strong></td>
<td>300–600 mg orally then 75 mg a day</td>
<td>60 mg orally then 10 mg a day</td>
<td>180 mg orally then 90 mg twice a day</td>
<td>30 µg/kg bolus and 4 µg/kg/min infusion</td>
</tr>
<tr>
<td><strong>Dosing in CKD</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Stage 3 (eGFR 30–59 mL/min/1.73 m$^2$)</td>
<td>No dose adjustment</td>
<td>No dose adjustment</td>
<td>No dose adjustment</td>
<td>No dose adjustment</td>
</tr>
<tr>
<td>• Stage 4 (eGFR 15–29 mL/min/1.73 m$^2$)</td>
<td>No dose adjustment</td>
<td>No dose adjustment</td>
<td>No dose adjustment</td>
<td>No dose adjustment</td>
</tr>
<tr>
<td>• Stage 5 (eGFR &lt;15 mL/min/1.73 m$^2$)</td>
<td>Use only for selected indications (e.g. stent thrombosis prevention)</td>
<td>Not recommended</td>
<td>Not recommended</td>
<td>No dose adjustment</td>
</tr>
<tr>
<td><strong>Binding reversibility</strong></td>
<td>Irreversible</td>
<td>Irreversible</td>
<td>Reversible</td>
<td>Reversible</td>
</tr>
<tr>
<td><strong>Activation</strong></td>
<td>Prodrug, with variable liver metabolism</td>
<td>Prodrug, with predictable liver metabolism</td>
<td>Active drug, with additional active metabolite</td>
<td>Active drug</td>
</tr>
<tr>
<td><strong>Onset of loading dose effect$^b$</strong></td>
<td>2–6 hours$^a$</td>
<td>30 min$^a$</td>
<td>30 min$^a$</td>
<td>2 min</td>
</tr>
<tr>
<td><strong>Duration of effect</strong></td>
<td>3–10 days</td>
<td>7–10 days</td>
<td>3–5 days</td>
<td>1–2 hours</td>
</tr>
<tr>
<td><strong>Withdrawal before surgery</strong></td>
<td>5 days$^c$</td>
<td>7 days$^c$</td>
<td>5 days$^c$</td>
<td>1 hour</td>
</tr>
<tr>
<td><strong>Plasma half-life of active P2Y$_{12}$ inhibitor$^d$</strong></td>
<td>30–60 min</td>
<td>30–60 min$^d$</td>
<td>6–12 hours</td>
<td>5–10 min</td>
</tr>
<tr>
<td><strong>Inhibition of adenosine reuptake</strong></td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes (‘inactive’ metabolite only)</td>
</tr>
</tbody>
</table>

$^a$ Assumed to be peak effect, $^b$ Assumes peak effect is defined as 10–20% plasma concentrations above baseline, $^c$ Assumes 5 days' washout period, $^d$ Assumes 30–120 min half-life.
Management of Patients of High Bleeding Risk (HBR)

PCI patient

- Not HBR
  - DES and Guidelines
- HBR
  - DCS and short DAPT

• HBR Patients
• Mostly excluded from device and antiplatelet trials
• Never specifically studied
What is the Ideal Duration of DAPT?

• Safety and Efficacy of prolonged DAPT

• Trade off between thrombotic and bleeding events

• Use of new generation DES in current practice

• One size does not fit all, prolonged DAPT may not be applied to everyone
## Duration of DAPT post stenting: Guidelines

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</thead>
<tbody>
<tr>
<td>Stent (BMS or DES) in ACS</td>
<td>At least 12 months (COR1, LOE B). Longer duration may be considered in patients with DES (COR IIB, LOE C)</td>
<td>Up to 12 months (COR1, LOE A)</td>
<td>Up to 12 months</td>
<td>12 months (COR1, LOE B)#.</td>
</tr>
<tr>
<td>BMS in non-ACS</td>
<td>At least 1 month (min 2 weeks if increased bleeding risk, ideally up to 12 months) (COR I, LOE B)</td>
<td>At least 1 month (COR1, LOE A)</td>
<td>According to device specific instructions</td>
<td>Endorses US Guideline</td>
</tr>
<tr>
<td>DES in non-ACS</td>
<td>At least 12 months (COR 1, LOE B)</td>
<td>6 months (COR 1 LOE B)</td>
<td>At least 12 months</td>
<td>Endorses US Guideline</td>
</tr>
<tr>
<td>Secondary prevention</td>
<td>May be considered (COR IIB, LOE B)</td>
<td>Selected patients at high risk of ischaemic events</td>
<td>Not recommended beyond 12 months</td>
<td>Consider in patients with recurrent ischaemic events</td>
</tr>
</tbody>
</table>

ACS- Acute Coronary Syndrome, BMS- Bare metal Stent, COR- Class of Recommendation, DES- Drug Eluting Stent, LOE- Level of Evidence.

Need to strike a balance between stent thrombosis and bleeding over time

Incidence rates and standardized incidence risk difference for stent thrombosis and clinically significant bleed per 100 person/year between S-DAPT and L-DAPT

**Table 2** IRs and Standardized IRDs for Stent Thrombosis and Clinically Significant Bleeding per 100 Persons/Year Between S-DAPT and L-DAPT

<table>
<thead>
<tr>
<th>Study (Ref. #)</th>
<th>Stent Thrombosis</th>
<th>Clinically Significant Bleeding</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>S-DAPT</td>
<td>L-DAPT</td>
</tr>
<tr>
<td></td>
<td>No. of Events</td>
<td>IR*</td>
</tr>
<tr>
<td>ARCTIC-Interruption (21)</td>
<td>3</td>
<td>0.33</td>
</tr>
<tr>
<td>DAPT (7)</td>
<td>69</td>
<td>0.80</td>
</tr>
<tr>
<td>DES-LATE (22)</td>
<td>25</td>
<td>0.29</td>
</tr>
<tr>
<td>EXCELLENT (19)</td>
<td>6</td>
<td>0.83</td>
</tr>
<tr>
<td>ISAR-SAFE (16)</td>
<td>5</td>
<td>0.50</td>
</tr>
<tr>
<td>ITALIC (17)</td>
<td>3</td>
<td>0.66</td>
</tr>
<tr>
<td>OPTIMIZE (15)</td>
<td>13</td>
<td>0.84</td>
</tr>
<tr>
<td>PRODIGY (23)</td>
<td>15</td>
<td>0.80</td>
</tr>
<tr>
<td>RESET (14)</td>
<td>2</td>
<td>0.19</td>
</tr>
<tr>
<td>SECURITY (18)</td>
<td>2</td>
<td>0.29</td>
</tr>
<tr>
<td>Combined</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

*Results expressed as 100 persons/year.
CI = confidence interval; IR = incidence rate; IRD = incidence risk difference; other abbreviations as in Table 1.

For every ST event averted with LT-DAPT, approx. 2.1 extra CSB are estimated to occur (approx. 0.45 ST/0.21 CSB per 100 person/year)

Giustino, Drangas et al, JACC 2015, LT-DAPT: Long Term Dual Antiplatelet therapy; CSB: Clinically Significant Bleeding
BioFreedom Drug Coated stent

• Polymer Free
• Rapid drug release (BA9) via porous-eluting stents

• Avoid any possible polymer related adverse effects
• Safe to shorten DAPT

LEADERS FREE: 1 mth DAPT after DES, if necessary

• First RCT dedicated to HBR patients

• Polymer free DES vs BMS with 1 month of DAPT

• Together with an ultra short (1 month) DAPT course, BA9-DCS was both significantly safer and more effective than a control BMS in HBR patients

• BioFreedom\textsuperscript{R} Drug coated stent (DCS) with 1 mth DAPT shld be considered as first line therapy for HBR patients.

Proposed Algorithm for DAPT after new gen DES implantation in pts with stable CAD

High risk period of stent related thrombotic complications

- PCI with new-generation DES implantation in patients with stable CAD
- Mandatory DAPT
- Pathobiology
  - Vascular healing
  - Stent strut endothelialisation
  - Antiproliferative drug elution

Patient assessment:
- Bleeding risk outweighs ischaemic risk
  - Bleeding risk factors:
    - Anaemia
    - Previous bleeding
    - Haemorrhagic diathesis
    - Chronic kidney disease
    - Chronic oral anticoagulation
  - Stop DAPT
- Ischaemic event on DAPT
  - Atherothrombotic risk factors:
    - Complex coronary anatomy (High SYNTAX score)
    - Anaemia
    - Chronic kidney disease
    - Previous myocardial infarction
    - Peripheral artery disease
    - Arterial hypertension
    - Diabetes
  - Continue DAPT
- Bleeding event on DAPT
- Ischaemic event on DAPT

<table>
<thead>
<tr>
<th>PCI</th>
<th>3–6 months</th>
<th>&gt;6 months</th>
</tr>
</thead>
</table>

DAPT Score

Low DAPT Score (<2)
NNT to prevent ischaemia= 153
NNT to cause bleeding= 64

High DAPT Score (≥2)
NNT to prevent ischaemia= 34
NNT to cause bleeding= 272

Yeh, R et al Jama 2016. DAPT score. How to individualise therapy.
Current Status

• After DES, longer DAPT is associated with protection against ischaemic events but increases the risk of bleeding significantly as well as possibly all-cause mortality.

• Spontaneous bleeding events are strongly and consistently associated with increased risk of mortality. While difficult to evaluate in clinical research, these events are important to patients.

• New generation DES have significantly improved stent related thrombotic events thus attenuating the benefit of prolonged DAPT in this patient group.

• Prolongation of DAPT after the mandatory period might be considered after careful evaluation of the individual thrombotic events and haemorrhagic risk.

• Optimal duration of DAPT in most DES patients should be shorter rather than longer, but should be customised based on the ischaemic benefit and bleeding risk for each patient.
Advances in Intravascular imaging: IVUS and OCT and A Shift in Focus

**Angiographic luminal stenosis**

**Intravascular Characterisation**
- More accurate assessment of luminal dimensions
- Underlying plaque composition
- Better understanding of a wide spectrum of pathophysiological disease processes affecting the coronary artery post stent implantation.

**Functional Assessment**
- Enhanced assessment of stenotic lesions

- Better assessment of underlying CAD
- Select proper treatment for patient
- Avoid Unnecessary Procedures
- Better procedural guidance and planning
- Optimise post deployment stent performance
- Improve clinical outcomes
Advances in Intravascular Assessment

- Fractional Flow reserve (FFR)
- Intravascular Ultrasound (IVUS)
- Optical Coherence Tomography (OCT)
Fractional flow reserve (FFR)

• Ratio of maximal hyperemic flow across a coronary lesion compared with the maximal hyperemic flow in the same artery without the stenosis

• Ischaemic threshold: 0.8

• Advantages
  • 1) revascularisation (either percutaneous or surgical) is justified best by the presence of ischaemia
  • 2) angiographic analysis sometimes fails to establish the hemodynamic significance of coronary stenotic lesions with accuracy especially those in the range between 50% and 70% diameter stenosis.
FFR is a measurement used to assess the severity of coronary artery disease. It is calculated as the ratio of the maximum flow in the coronary artery when the heart is at rest to the maximum flow when hyperemic conditions are present.

\[ FFR = \frac{Q_{S_{\text{max}}}}{Q_{N_{\text{max}}}} \]

where:
- \( Q_{S_{\text{max}}} \) is the maximum flow at rest
- \( Q_{N_{\text{max}}} \) is the maximum flow during hyperemia

For FFR values:
- Above 0.8: No significant ischaemia
- Below 0.8: Significant ischaemia

In the diagram, the pressure wire is used to measure pressure differences across the lesions, which are then used to calculate the FFR.
Event-free survival was not different between the Defer and Perform groups (p = 0.52), but was significantly worse in the Reference group (p = 0.03).

Stable Intermediate Lesion and FFR ≥ 0.75: The risk of cardiac death or myocardial infarction related to this stenosis is <1% per year and not decreased by stenting.

FFR is a sensitive index of ischaemia

FAME: FFR vs AngioGuided
1 year MACE (Death, nonfatal MI, and repeat revascularization)

FFR-guided PCI: Stenting of indicated lesions only if the FFR was 0.80 or less.

Tonino et al/ NEJM 2009; 213-26

De Bruyne et al/ NEJM 2012; 991-1001
Uses of FFR
Newer Coronary Imaging Technologies

• IVUS (Intravascular Ultrasound)
• Frequency domain optical coherence tomography (FD-OCT)

• Enhanced capabilities
  • Improve visualisation of CAD -> optimization of treatment
  • Better understanding of coronary pathologies (especially in ACS)
  • Better understanding of post intervention healing (stent thrombosis)

• Possible Impacts
  • Better diagnosis and understanding of pathophysiology
  • Altering clinical practice and improving treatment outcomes
  • Guide future research and development for better devices
Uses of OCT and IVUS

• Baseline Information
  • Tissue and plaque characterization
    • (fibrous, lipid core, calcium cap thickness, thrombus)
    • Guiding PCI strategy (stent size and length, vulnerable plaque)

• During and After PCI
  • Stent strut apposition/ malapposition, dissection, thrombus

• Follow up Assessment
  • Neointimal coverage, thickness and area, restenosis
  • Late thrombosis

• Research
  • Stent / scaffold development, DAPT duration
Virtual Histology vs Grayscale IVUS
<table>
<thead>
<tr>
<th>Feature</th>
<th>FD-OCT (OPTIS)</th>
<th>TD-OCT (M3)</th>
<th>IVUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flame Rate</td>
<td>180 frames/s</td>
<td>20 frames/s</td>
<td>30 frames/s</td>
</tr>
<tr>
<td>Lines/ Flame</td>
<td>560</td>
<td>240</td>
<td>256</td>
</tr>
<tr>
<td>Resolution (Lateral)</td>
<td>19 μm</td>
<td>39 μm</td>
<td>200 μm</td>
</tr>
<tr>
<td>Resolution (Axial)</td>
<td>12 - 15 μm</td>
<td>15 - 20 μm</td>
<td>100 - 150 μm</td>
</tr>
<tr>
<td>Pull-back Speed (mm/sec.)</td>
<td>18/36</td>
<td>1.5</td>
<td>0.5 - 1</td>
</tr>
<tr>
<td>Penetration</td>
<td>1-2 mm</td>
<td>1-2 mm</td>
<td>~8 mm</td>
</tr>
<tr>
<td>Max. Scan Diameter</td>
<td>10 mm</td>
<td>6.8 mm</td>
<td>10 mm</td>
</tr>
<tr>
<td>Blood Removal</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
15 year ISR
ACS after LCX stent 6 weeks earlier- “stent in stent thrombosis”

ACS after LCX stent 6 weeks earlier- “stent in stent thrombosis” Post PCI
RCA 2 year follow up after BRS

Fam JM, Robert-Jan van Geuns et al (a/w submission)
Future Trend

Imaging in the Cathlab:

Online coregistration

Baseline OCT Pullback: Culprit lesion in mid RCA

OCT: SJM (Dragonfly Duo/Lightlab)
3D-OCT

- With its high speed pullback and high resolution, OCT is suitable imaging modality for 3D imaging.

- In bifurcation, 3D-OCT may guide positioning of the wire through the appropriate distal cell.

- Early study suggests that such a guidance strategy reduced the incidence of malapposition in bifurcation.

Use of 3D Visualisation in assessing stent deployment result

OCT: SJM (Dragonfly Duo/Lightlab)
Conclusion 1: Current and Future Direction in Stents

• Current DES have improved safety and efficacy profile compared to earlier generation DES
• They are safer than BMS
• Current DES still not ideal, late events due to late progression- late stent thrombosis or in stent restenosis

• Future innovations directed at bioresorbable polymer-based devices or polymer free systems as well with completely bioresorbable vascular scaffolds (BRS)
  • Reduce stent thrombosis and improve late outcomes
• Trials are underway to demonstrate BRS reduce very late events and/or stabilise/ regress plaque
Conclusion 2: Antiplatelets and Drug Eluting Stents

• After DES, longer DAPT is associated with protection against ischaemic events but increases the risk of bleeding significantly as well as possibly all-cause mortality.

• New generation DES have significantly improved stent related thrombotic events thus reducing the benefit of prolonged DAPT in this patient group.

• Optimal duration of DAPT in most DES patients should be shorter rather than longer, but should be customised based on the ischaemic benefit and bleeding risk for each patient.
Conclusion 3: Functional Assessment and Intravascular Imaging

• Shift in focus from concentrating on the degree of angiographic luminal stenosis to detailed intravascular characterization of the coronary artery.

• Integrated use of FFR and IVUS/OCT can reveal hidden pathophysiology of coronary artery disease and help to select the proper treatment for the patient and avoid unnecessary procedure
  • Less DES
  • Less Surgery
  • Simplified procedure
  • Improved Clinical Outcomes